Sunao Furukawa : A New Desoxidation Reaction of Aromatic N-Oxides.

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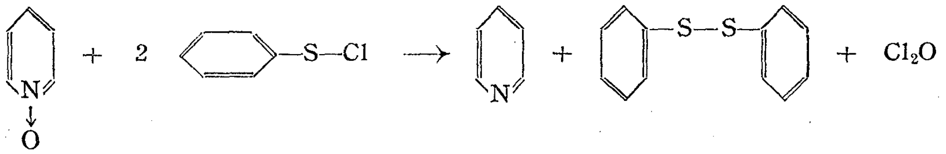
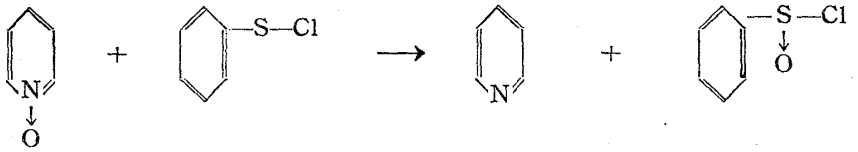
The desoxidation of pyridine and quinoline 1-oxide derivatives had generally been carried out by catalytic hydrogenation or with nascent hydrogen, as for example, with zinc and acetic acid, and other methods included phosphorus trichloride in chloroform solution,¹⁾ heating at high temperature,²⁾ and heating in the presence of selenium in sulfuric acid.³⁾

During the studies on the reaction of pyridine 1-oxide with acid chlorides, it was occasionally observed that phenylsulfenic chloride reacted with pyridine or quinoline 1-oxide in chloroform solution to effect desoxidation, and phenylsulfenic chloride itself converted to diphenyl disulfide in about 80% yield.

This reaction mechanism was assumed to proceed in the following two ways :



(1)



(2)

When it reacted according to (2), phenylsulfinic chloride should be produced but the author did not succeed in isolating phenylsulfinic chloride from the reaction mixture.

In the case of reaction (1), there is no determination method for chlorine monoxide, but diphenyl disulfide was actually isolated from the reaction mixture. Even if it were not sufficient evidence, the yield of desoxidation was better when two moles of phenylsulfenic chloride was used for one mole of the 1-oxide than when one mole of phenylsulfenic chloride was used. Therefore, this desoxidation was assumed to proceed according to reaction (1).

This desoxidation reaction was applied to several derivatives of pyridine and quinoline 1-oxides and the results are summerized in Table I.

TABLE I.

1-Oxide of	Yield(%)(solvent, $CHCl_3$)	
	φ-S-Cl 1 mole	φ-S-Cl 1 mole
Pyridine	56～62%	80～85%
4-Picoline	40～50%	80～82%
2-Picoline	55～65%	80～85%
4-Chloropyridine	40～45%	75～80%
Quinoline	60～65%	80～90%
4-Nitropyridine	Recovered	material was recovered
4-Nitroquinoline	——	4-chloroquinoline(about 10%), and some material recovered.

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1) M. Hamana : J. Pharm. Soc. Japan, **71**, 263(1951).

2) M. Katada : *Ibid.*, **67**, 54(1947).

3) M. Shimizu, R. Dohmori : *Ibid.*, **72**, 1643(1952).

As shown in the above table, 4-nitropyridine 1-oxide did not react at the boiling temperature of chloroform. This resistance of 4-nitropyridine 1-oxide to desoxidation was recognized in aromatic N-oxides with trivalent phosphorus derivatives by Hamana.[4] The simple derivatives of pyridine and quinoline 1-oxides, except 4-nitropyridine 1-oxide, were desoxygenated by phenylsulfenic chloride in a fairly good yield. Furthermore, sulfur chloride was selected as the simplest compound having an —S—Cl bond and desoxygenative reaction of aromatic N-oxide with it was examined. Similarly, sulfur chloride was proved to react desoxygenatively in chloroform solution to aromatic N-oxides in a good yield. The results of the reaction of some derivatives of pyridine and quinoline 1-oxides with sulfur chloride are shown in Table II.

TABLE II.

1-Oxide of	Yield(%) (solvent, $CHCl_3$) 2 moles of S_2Cl_2 used	1-Oxide of	Yield(%) (solvent, $CHCl_3$) 2 moles of S_2Cl_2 used
Pyridine	80∼83	4-Picolin	85∼90
2-Picolin	85∼90	Quinoline	80∼85

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Experimental

General Procedure of Desoxygenation by Phenylsulfenic Chloride—1) 2-Picoline 1-oxide: Into a solution of 1 mole of 2-picoline 1-oxide in dry $CHCl_3$ was added slowly a solution of 2 moles of phenylsulfenic chloride in dry $CHCl_3$ and the mixture was refluxed gently for 5∼6 mins. on a water bath. The reaction mixture turned dark brown. After cooling, the solvent was distilled off, a small amount of water was added to the reaction mixture, the residue was saturated with K_2CO_3, and extracted with ether. The ether solution was extracted with 10% HCl and then the acid solution was concentrated in vacuum. The residue was made strongly alkaline with NaOH and extracted with ether. The ether solution was dried over K_2CO_3 and the residual basic oil distilled at b.p. 127°; yield, 85%. The picrate, m.p. 165°, of the distillate was identified as the picrate of 2-picoline by admixture.

The solvent was distilled off from the ether solution left after extraction with 10% HCl and this residue, partialy crystallized on standing, and was distilled under a diminished pressure (3 mm. Hg). The distillate of b.p$_3$ 150∼170°; yield, 80%, and recrystallized from EtOH, m.p. 62∼63°. It was identified as diphenyl disulfide by admixture.

General Procedure of Desoxygenation by Sulfur Chloride—1) Pyridine 1-oxide: Into a solution of 1 mole of pyridine 1-oxide in dry $CHCl_3$ was added the solution of 2 moles of S_2Cl_2 in dry $CHCl_3$ and refluxed for about 1 hr. on a water bath. Sulfur precipitated from the reaction mixture. After the solvent was distilled off, the residue was decomposed with a small amount of ice, added with 10% HCl. The acid solution was filtered, the filtrate was concentrated in vacuum, the residue was made alkaline with K_2CO_3, and extracted with ether. The ether solution was dried over K_2CO_3, the solvent was evaporated, and the oily residue was obtained. The residue distilled at b.p. 115°. The picrate, m.p. 166°, of the distillate showed no depression of m.p. when admixed with pyridine picrate.

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[4] M. Hamana: J. Pharm. Soc. Japan, **75**, 121(1955).